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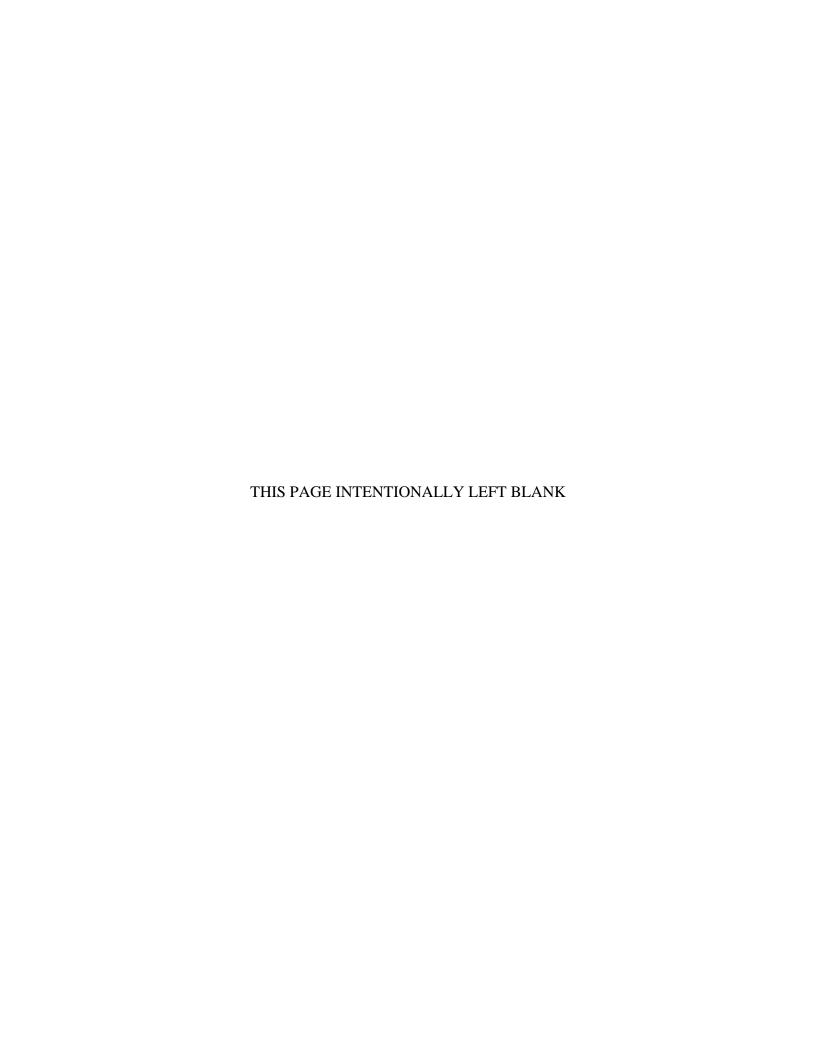
High Frequency Automatic Recording Package Data Summary Report PS05, August 4, 2008 – January 6, 2009

> by Tetyana Margolina

> > August 2010

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This report was prepared by:	
	Tetyana Margolina Research Associate
Reviewed by:	Released by:
Jeffrey Paduan Department of Oceanography	Karl Van Bibber Vice President and Dean of Research



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This is the first in a series of reports on the project, which seeks to assemble a census of marine mammal vocalizations in the high-frequency acoustic recording package (HARP, Wiggins and Hildebrand, 2007) data collected by the NPS Oceanography Department off Point Sur beginning in October 2006. The present report provides an initial summary of marine mammal vocalizations detected and identified in records from the fifth HARP deployment between August 4, 2008 and January 6, 2009. Data was acquired in the 10 Hz-100 kHz frequency band at a 200 kHz sampling frequency for 5 minutes during each quarter hour. Long-term spectral averages were created for three frequency bands (10 Hz-1000 Hz, 1 kHz-5 kHz, 5 kHz-100 kHz) and then scanned for marine mammal vocalizations. Detected calls of blue whales, fin whales, humpback whales, as well as echolocations of sperm whales, beaked whales, and dolphins are presented as occurrence time diagrams.

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ABSTRACT

This is the first in a series of reports on the project, which seeks to assemble a census of marine mammal vocalizations in the high-frequency acoustic recording package (HARP, Wiggins and Hildebrand, 2007) data collected by the NPS Oceanography Department off Point Sur beginning in October 2006. The present report provides an initial summary of marine mammal vocalizations detected and identified in records from the fifth HARP deployment between August 4, 2008 and January 6, 2009. Data was acquired in the 10 Hz–100 kHz frequency band at a 200 kHz sampling frequency for 5 minutes during each quarter hour. Long-term spectral averages were created for three frequency bands (10 Hz-1000 Hz, 1 kHz-5 kHz, 5 kHz-100 kHz) and then scanned for marine mammal vocalizations. Detected calls of blue whales, fin whales, humpback whales, as well as echolocations of sperm whales, beaked whales, and dolphins are presented as occurrence time diagrams.

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I. DATA AND METHODS

The PS05 HARP was deployed on top of Sur Ridge at 36°23.4′N, 122°18.4′W on August 4, 2008 and recovered on January 6, 2009. The instrument location is shown in Fig. 1. Bottom depth at the deployment site was 837 m. A schematic diagram of the HARP mooring (courtesy of Ms. Marla Stone, Naval Postgraduate School) is given in Fig. 2. Temperature, salinity, and current data collected on the mooring have been described by Zamora (2009).

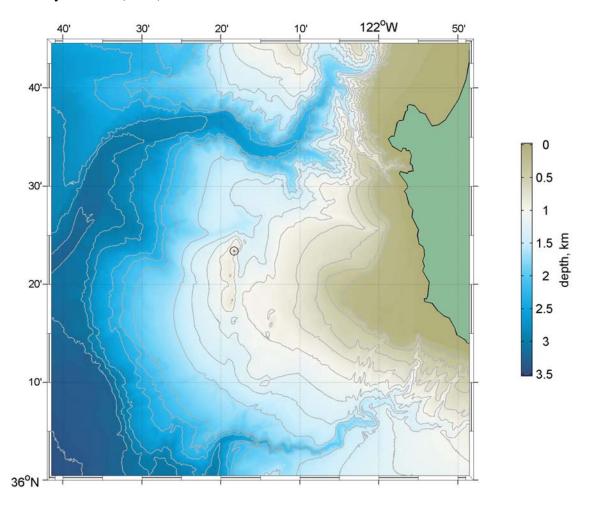


Figure 1. Chart showing PS05 HARP deployment location (red dot) to the west of Point Sur, California. The scale to the right indicates bottom depth in kilometers. Isobaths (gray lines) are shown at 200 m interval.

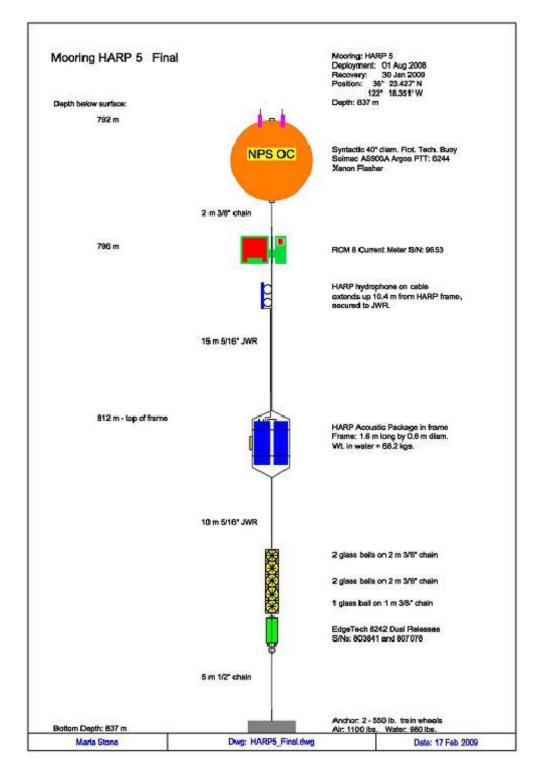


Figure 2. Schematic diagram showing details of the PS05 HARP. Note that objects and distances are not drawn to scale.

Data was acquired at a 200 kHz sampling frequency for 5 minutes during each quarter hour. Recording stopped for ~ 3.2 days on September 10, 2008 at 12:18:45 GMT and resumed at 17:00:00 GMT on September 13, 2008. Beginning January 1, 2009, nearly continuous data was recorded until January 6, 2009. The PS05 HARP deployment provided a total of 276 hours of data over the 154 days the mooring was deployed (see Fig. 3).

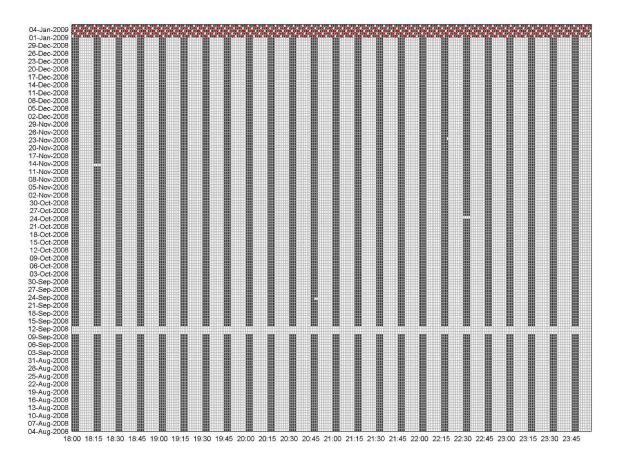


Figure 3. PS05 HARP schedule from 06:00:00 PM to 11:58:45 PM of each day. Each cell corresponds to one raw file of 75 s duration. Red crosses denote records of non-standard length.

The PS05 HARP data were manually scanned for marine mammal vocalizations using the "logger" version of the Scripps *Triton* software (v1.7b.20100426_loggers). The frequency range 10 Hz – 100 kHz was divided into three parts: 10-1000 Hz, 1 to 5 kHz, and 5-100 kHz. This allowed targeting different species of baleen and toothed whales by the frequency band of their vocalization. The data were down-sampled by factors 20 and

100 to detect vocalizations in mid-frequency and low-frequency bands, respectively. Then long-term averaged spectrograms (LTSAs) were created with 5 s time resolution and 1/10/100 Hz frequency resolution for low/mid/high frequency bands, respectively. As an example, Fig. 4 shows LTSAs containing echolocation clicks of Pacific white-sided dolphin (upper panel), humpback whale song (middle panel), and blue whale song (lower panel). Details on corresponding sampling frequencies and time/frequency bins are given in the figure caption. Note that the ranges of y-axes in the middle and lower panel have been adjusted so as to better show the whale vocalizations.

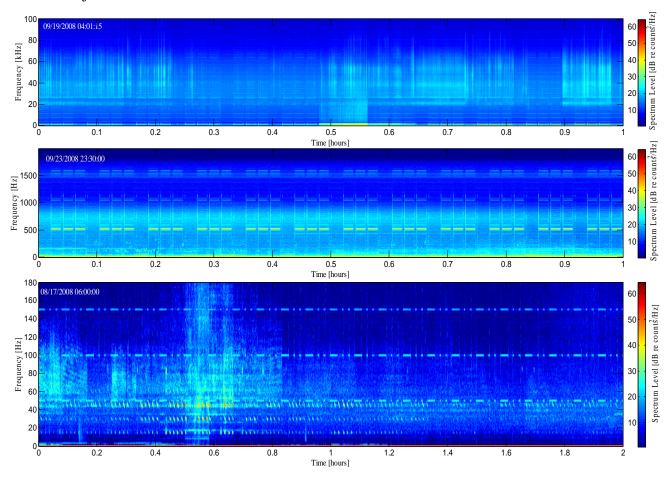


Figure 4. Examples of LTSAs for different frequency bands.

Upper panel – Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) echolocation clicks, sampling frequency 200 kHz, 5 s/100 Hz time/frequency bins; middle panel – humpback whale (*Megaptera novaeangliae*) song, sampling frequency 10 kHz, 5 s/10 Hz time/frequency bins; lower panel – blue whale (*Balaenoptera musculus*) song, sampling frequency 2 kHz, 5 s/1 Hz time/frequency bines.

II. RESULTS

Table 1 summarizes detected and identified marine mammal vocalizations for the PS05 HARP deployment. Figs. 5–14 illustrate occurrence time for different species and call types in 75 s bins.

Table 1. Summary of identified marine mammal vocalizations.

Species	Call type	Hours	Percentage	Days with	Percentage
		of	of total	vocalizations	of total
		vocalizations	recordings		deployment
					duration
Blue whale	various	270	27%	130	84%
	A call	129	11%	100	65%
	B call	247	24%	128	83%
	D call	43	4%	62	40%
Fin whale	20 Hz	109	9%	90	58%
Humpback	various	149	11%	111	72%
whale					
Sperm whale	echolocation	24	<2%	58	38%
Beaked	echolocation	3	<0.1%	16	10%
whale					
Dolphins	echolocation/	122	11%	127	82%
(total)	whistles				
Risso's	echolocation	<1	<0.1%	1	<1%
dolphin					
Pacific	echolocation/	23	2%	40	26%
white-sided	whistles				
dolphin					
Unidentified	echolocation/	99	8%	125	81%
dolphin	whistles				

Blue whales were present almost all of the time (130 of 154 days) during the PS05 recordings (see Figs. 5–7). The blue whale vocalizations contained A and B calls (ABAB and ABBB songs), as well as D calls which are associated with feeding. Vocalizations intensified in September 2008 and stopped after December 24, 2008.

Observed fin whale calls were mostly 20 Hz calls, and were also present throughout the PS05 data until the end of December 2008 (see Fig. 8). There was no obvious diurnal or seasonal variability in the fin whale vocalizations, except relative intensification at the beginning of November 2008.

Humpback whale vocalizations were continually present in the PS05 data but 75% of them were detected in October and November 2008 (see Fig. 9). In August–September and December–beginning of January, humpback whale vocalizations were either sparse or short. Distribution and repertoire of the detected humpback vocalizations will be analyzed in a separate report.

Sperm whale clicks were evenly distributed from August, 2008 to January 2009 (see Fig. 10).

Dolphin vocalizations detected included echolocation clicks, whistles, and burst pulses. Dolphins were present throughout the PS05 deployment and intensified during night time from September, 2008, until January, 2009 (see Figs. 11–13). Pacific white-sided dolphins (Fig. 11) were identified for 36 days in August and September, two days in October, and two days in November. A single occurrence of Risso's dolphin (Fig. 12) was detected on August 30, 2008.

Echolocation clicks of beaked whales were detected during only 16 of 154 days (see Fig. 14). During the first part of the deployment (five days from late August until mid-October, 2008), upswept clicks of ~20 kHz peak frequency were identified. Likely, these echolocation clicks were produced by Baird's beaked whales. Five occurrences of upswept clicks were detected in late December, 2008 – early January, 2009; these were Cuvier's and, possibly, Cuvier's-like upswept echolocation pulses. The latter were characterized by longer duration and inter-click intervals as compared to Cuvier's echolocation clicks, as well as specific changes of echolocation types ("40 kHz Pt. Sur beaked whales" by Scripps' classification, S. Baumann-Pickering, personal

communication, and Baumann-Pickering et al., 2009). The duration of beaked whales vocalizations was too short to make more certain identification. It is expected that beaked whales will be detected and identified in the PS06 HARP data. In this case, a joint analysis of beaked whale echolocation clicks during winter 2008/2009 will be presented in the next data summary report.

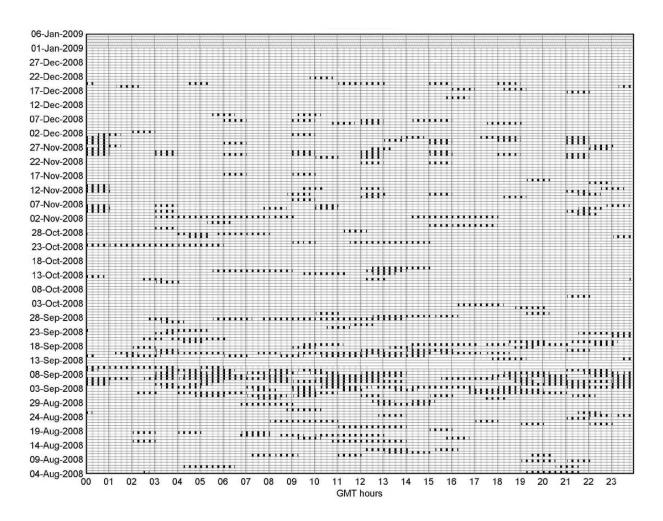


Figure 5. Blue whale A calls in 75 s bins.

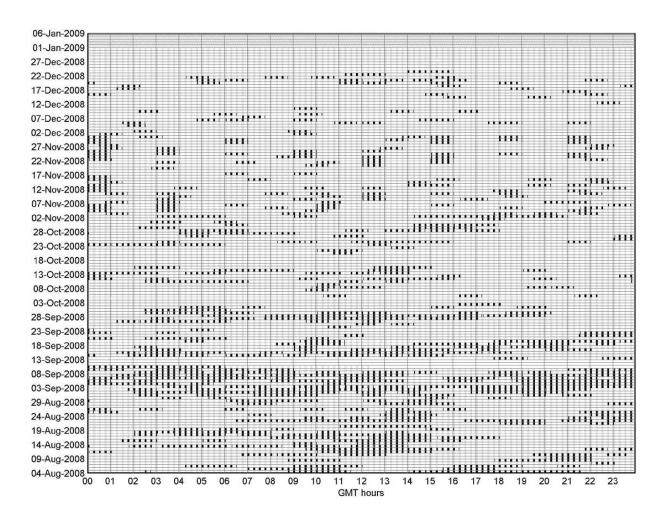


Figure 6. Blue whale B calls in 75 s bins.

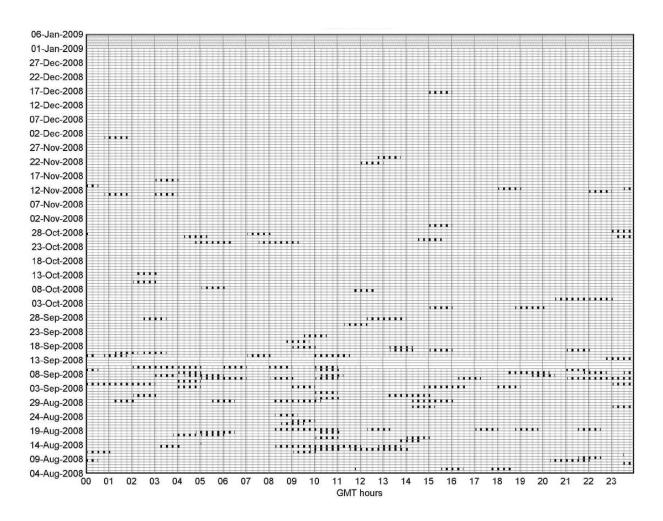


Figure 7. Blue whale D calls in 75 s bins.

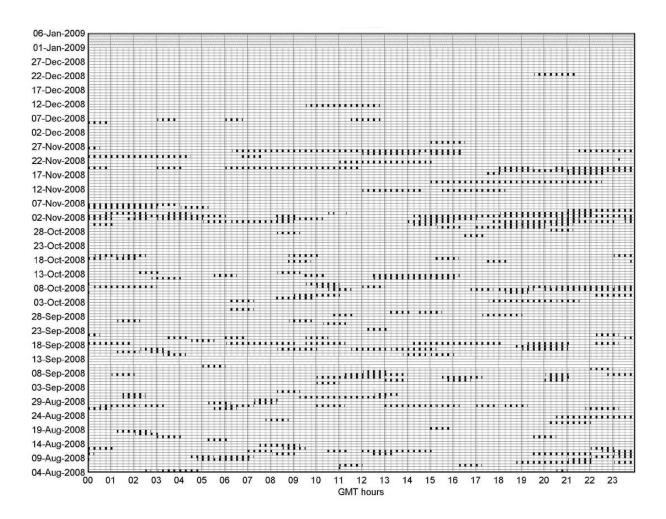


Figure 8. Fin whale calls in 75 s bins.

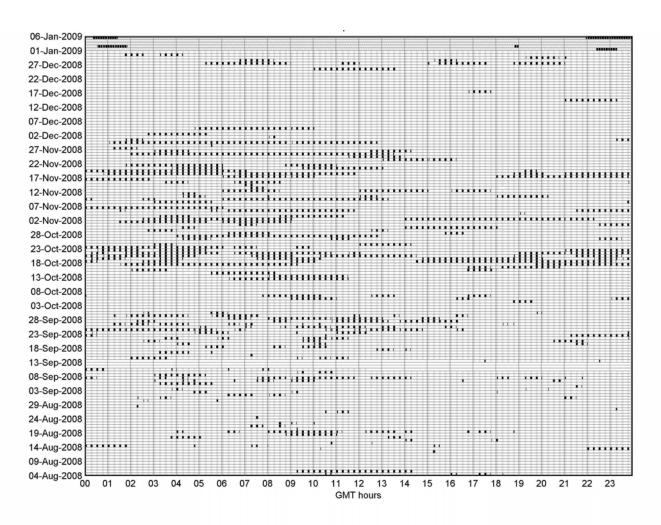


Figure 9. Humpback whale vocalizations in 75 s bins.

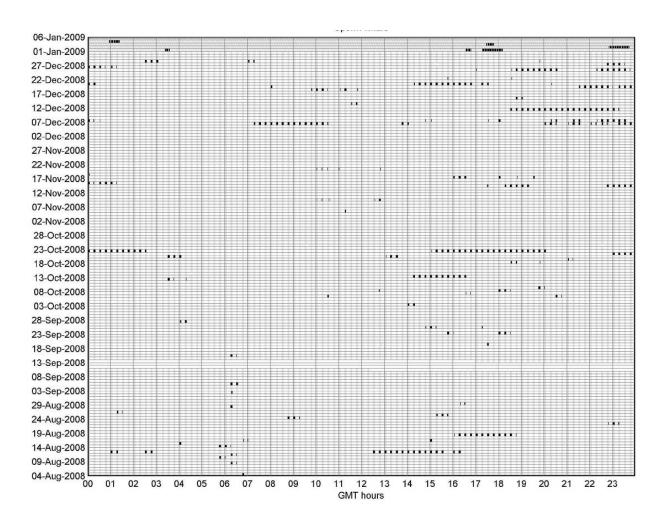


Figure 10. Sperm whale echolocation clicks in 75 s bins.

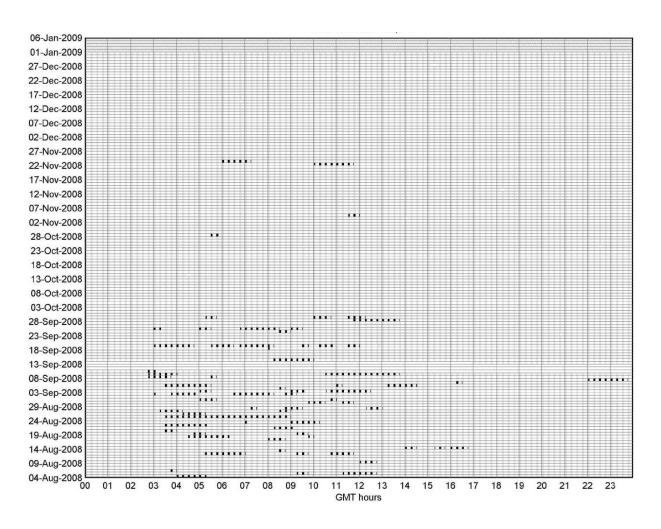


Figure 11. Echolocation clicks of Pacific white-sided dolphin in 75 s bins.

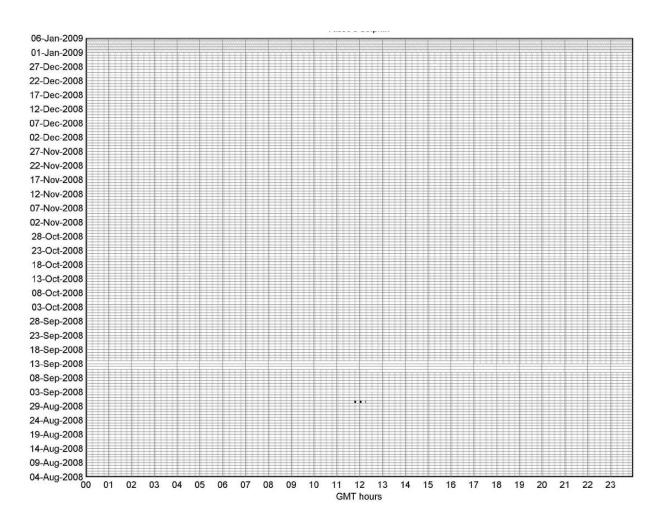


Figure 12. Risso's dolphin echolocation clicks in 75 s bins.

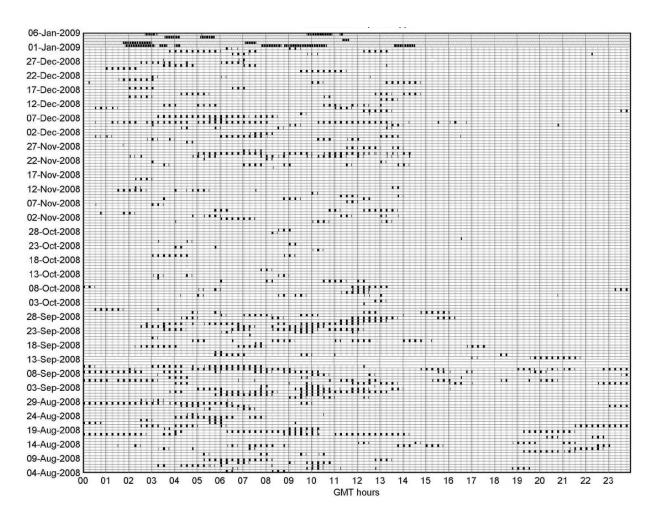


Figure 13. Echolocation clicks and whistles of unidentified dolphins in 75 s bins.

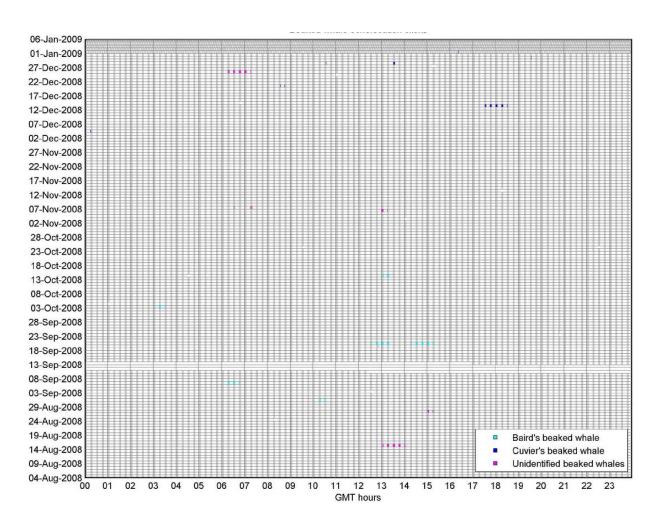


Figure 14. Beaked whale echolocation clicks in 75 s bins.

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75. Anne Simonis
Scripps Institution of Oceanography
University of California
La Jolla, CA